UK Fluids Conference 2023, 17-19th October 2023, Glasgow, UK

Session: Computational Fluid Dynamics

Vibrationally-driven solid particle attractors in non-uniformly heated systems

Balagopal Manayil Santhosh[1] and Marcello Lappa[1*]

[1]Department of Mechanical and Aerospace Engineering, University of Strathclyde, James Weir Building, 75 Montrose Street, Glasgow, G1 1XJ, UK

Abstract:

Building on the recent discovery of solid particle attractors in thermo-vibrational flow driven by the interplay of (particle) inertial and (fluid) convective effects in finite-size containers, a new attempt is made to further expand our understanding of the relationship between the location, number and morphology of the emerging particle structures and the details of the thermal boundary conditions imposed on the walls of the fluid container. The considered thermal configuration features two adjacent thermally heated walls with a cold spot located in the center and two opposing walls which are cooled with the exception of a centrally heated zone (hot spot). Vibrations are applied along a direction parallel to all these walls in such a way that they are perpendicular to the gradients of temperature established between the thermal features pertaining to different boundaries. The Prandtl number, vibrational Rayleigh number and angular frequency are fixed to 6.11 (water at ambient temperature), $Ra_\omega=10^4$ and $\Omega=10^3$ respectively, with a particle stoke number value of $St= 5\text{x}10^{-6}$ and a particle-fluid density ratio of $\xi=2$. It is shown that the main emerging particle structures are generally a couple of elongated formations, each consisting of two mirror symmetric conical surfaces (having the base in common and opposing vertices). On varying the size of the central temperature spots, however, a modulation in the extension of these structures can be seen, which in a certain interval of the spot size are taken over by a kind of diffused "blob" accumulation produced by the expansion and coalescence of the two aforementioned otherwise disjoint attractors.